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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/695,285	10/28/2003	John W. Jacobs	NEC0253US	3952
33031	7590	03/07/2005	EXAMINER	
CAMPBELL STEPHENSON ASCOLESE, LLP			DOLAN, JENNIFER M	
4807 SPICEWOOD SPRINGS RD.			ART UNIT	
BLDG. 4, SUITE 201			PAPER NUMBER	
AUSTIN, TX 78759			2813	

DATE MAILED: 03/07/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/695,285

Applicant(s)

JACOBS ET AL.

Examiner

Jennifer M. Dolan

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) 12-20 is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1-11 is/are rejected.
- 7) ☐ Claim(s) ____ is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 28 October 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. ____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|--|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. ____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date <u>10/28/03</u> . | 6) <input type="checkbox"/> Other: ____ |

DETAILED ACTION

Election/Restrictions

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:
 - I. Claims 1-11, drawn to a method for forming an electronic interconnect, classified in class 438, subclass 622.
 - II. Claims 12-19, drawn to an integrated circuit including an interconnect, classified in class 257, subclass 700.
 - III. Claim 20, drawn to an apparatus for post-treating an IC having an interconnect, classified in class 134, subclass 100.1.

The inventions are distinct, each from the other because of the following reasons:

2. Inventions I and II are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case, the patentability in 'product-by-process' claims is based on product itself, even though such claims are limited and defined by process, and thus the product in such claim is unpatentable if it is the same as a product of prior art, even if prior product was made by a different process, (see *In re Thorpe, et al.*, 227 USPQ 964 (CAFC 1985)). Hence, the product as claimed is substantially the same as non-corroded interconnect structures formed by alternate processes, such as using an oxygenated plasma, nitric acid, or acetic acid treatment.

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3. Inventions I and III are related as process and apparatus for its practice. The inventions are distinct if it can be shown that either: (1) the process as claimed can be practiced by another materially different apparatus or by hand, or (2) the apparatus as claimed can be used to practice another and materially different process. (MPEP § 806.05(e)). In this case, the process as claimed could be practiced with an apparatus using a showerhead configuration rather than a nozzle, or without a step of specifically positioning the substrate relative to the nozzle.

4. Because these inventions are distinct for the reasons given above and have acquired a separate status in the art as shown by their different classification, restriction for examination purposes as indicated is proper.

5. During a telephone conversation with Eric Stephenson on 2/28/05 a provisional election was made without traverse to prosecute the invention of Group I, claims 1-11. Affirmation of this election must be made by applicant in replying to this Office action. Claims 12-20 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

6. Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

Claim Rejections - 35 USC § 102

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

8. Claims 1 and 3-7 are rejected under 35 U.S.C. 102(b) as being anticipated by U.S. Patent Publication No. 2002/0036001 to Ise.

Regarding claim 1, Ise discloses a method comprising: forming a tungsten plug (417) in a dielectric layer (24); forming an electrically conductive interconnect line (22) on the dielectric layer after formation of the tungsten plug (figure 8), wherein the tungsten plug is electrically connected to the interconnect line (figure 8; also see paragraphs 0056-0058), introducing a gas (ozone) into a liquid (water); and contacting the interconnect line with the gas introduced liquid after forming the interconnect line (see paragraph 0057).

Regarding claims 3-7, Ise teaches that the gas-introduced liquid is water with ozone dissolved therein (see paragraph 0057), which is inherently weakly acidic (and hence, has a pH between 3 and 7).

Claim Rejections - 35 USC § 103

9. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

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(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

10. Claims 1-8 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 6,358,329 to Muranaka et al. in view of U.S. Patent No. 5,336,371 to Chung et al.

Regarding claims 1-8, Muranaka discloses a method comprising: forming a tungsten plug (3) in a dielectric layer (1); forming an electrically conductive interconnect (5) on the dielectric layer after forming the plug, wherein the plug and interconnect are electrically connected (figure 5; column 1, lines 40-65); and rinsing the electrically conductive interconnect line with ultrapure water after forming the electrically conductive interconnect line (see column 5, lines 1-15) in order to rinse a photoresist stripper from the wafer (column 3, line 20 – column 4, line 10).

Muranaka fails to disclose that the rinsing fluid is a gas-introduced water, where the gas is carbon dioxide.

Chung discloses that a rinsing fluid comprising carbon dioxide dissolved in DI water should be used on semiconductor wafers having exposed aluminum structures in order to remove the resist stripper without corroding the aluminum structure (column 1, lines 32-68). Carbon dioxide introduced water inherently has a pH of about 4-6, and is more electrolytic and more acidic than pure water (see Chung, column 3, line 60 – column 4, line 5).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the resist stripper removal method of Muranaka, such that carbon dioxide dissolved in DI water is used in place of the ultrapure water for rinsing the

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photoresist stripper, as suggested by Chung. The rationale is as follows: A person having ordinary skill in the art would have been motivated to use carbon dioxide dissolved in DI water for rinsing the photoresist stripper, because Chung shows that CO₂ water is effective at removing the photoresist stripper materials (Chung, column 3, line 40 – column 4, line 5) while significantly reducing the corrosion of the exposed aluminum relative to pure water or DI rinses (see Chung, column 1, lines 50-67, column 2, lines 45-55). Since Muranaka is solving the exact same problem of reducing aluminum corrosion during a photoresist stripper rinse step, but uses more elaborate methods, such as strictly controlling the atmosphere during the water rinse (Muranaka, column 3, lines 35-60) or controlling the temperature of the water during the rinsing step (Muranaka, column 5, lines 1-15), it would have been apparent to a person skilled in the art that the use of CO₂-injected DI water would produce the result of low Al corrosion without the need for the elaborate process controls in Muranaka.

Regarding claim 10, Muranaka discloses that the cleaning fluids are sprayed onto the wafer (column 3, lines 20-30, column 4, lines 32-45; figures 2, 4).

11. Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ise et al in view of U.S. Patent No. 6,410,417 to Tsai et al.

Ise discloses performing a photoresist stripping operation on an aluminum interconnect, and then rinsing with ozone (oxygenated) water (paragraphs 0056-0058).

Ise fails to disclose a step of removing residual polymer after contacting the Al interconnect with the ozone water.

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Tsai teaches that a residual polymer layer is typically generated during the etching of the aluminum interconnect layer (column 3, lines 40-44), and that such a layer is typically removed after stripping the photoresist, and then contacting the Al interconnect with oxygen water (which is similar to ozone water; see column 1, lines 25-60; column 3, line 15-column 4, line 12).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to specify that for the interconnection of Ise, a residual polymer is removed after photoresist removal and oxygen-water exposure, as suggested by Tsai. The rationale is as follows: A person having ordinary skill in the art would have been motivated to remove a residual polymer layer after the photoresist removal step, because Tsai shows that etching of Al interconnects will generate a polymer layer, but the polymer layer can safely be removed after photoresist removal and exposure to oxygenated water (Tsai, column 3, line 15 – column 4, line 12). Since it would be apparent to a person skilled in the art that a residual polymer layer on the interconnect would contaminate the device and impede electrical connections, thus necessitating removal, and since Tsai shows that it is feasible to use a polymer stripper without experiencing tungsten corrosion after treatment of the structure with oxygen and water, it is well within the purview of a person skilled in the art to apply a residual polymer removal step after the oxygenated water treatment step to the interconnect of Ise, in order to remove any residual polymer generated by the interconnect etch.

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12. Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over Muranaka et al. in view of Chung et al. as applied to claim 1 above, and further in view of U.S.

Patent No. 6,284,055 to Dryer et al.

Muranaka fails to disclose the methodology of generating a gas-introduced liquid and introducing such a liquid to the wafer.

Dryer discloses a method for forming a CO₂ – introduced water, wherein carbon dioxide is introduced into a first chamber, and deionized water into a second chamber, the chambers separated by a porous membrane (column 6, line 20 – column 7, line 60), where the gas flows into the second chamber via the membrane (column 6, lines 20-25, 55-67) and dissolves into the liquid in the second chamber (column 6, lines 60-67).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to specify that the carbon dioxide-introduced water of Muranaka as modified by Chung is produced by injecting the carbon dioxide through a porous membrane, as suggested by Dryer. The rationale is as follows: A person having ordinary skill in the art would have been motivated to inject the carbon dioxide through a membrane, rather than conventional methods of injection, such as bubbling or sparging, because Dryer shows that passage through a membrane introduces the carbon dioxide in a smaller form, such that it is more completely dissolved and mixed in the water (Dryer, column 6, lines 55-67), reduces the incorporation of contaminating particles into the solution (see Dryer, column 1, lines 40-50), and largely prevents the occurrence of bubbles in the solution (Dryer, column 7, lines 1-7).

Conclusion

13. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

- a. U.S. Patent Publication No. 2003/0006513 to Gotoh et al. discloses the usage of carbonic acid dissolved water (substantially similar to CO₂-dissolved water) for preventing local cell action and corrosion between aluminum and other metal layers.
- b. U.S. Patent No. 6,277,742 to Wang et al. discloses the use of acidic or alkaline compositions to discharge the accumulated charge on a tungsten plug, and thereby prevent tungsten corrosion.
- c. U.S. Patent No. 6,851,873 to Muraoka et al. discloses a cleaning method and apparatus for injecting ozone into water and cleaning a wafer with ozone water.
- d. U.S. Patent Publication No. 2002/0053355 to Kamikawa et al. discloses a cleaning method and apparatus for semiconductor devices using CO₂-injected water.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jennifer M. Dolan whose telephone number is (571) 272-1690. The examiner can normally be reached on Monday-Friday 8:30am-5:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl W. Whitehead, Jr. can be reached on (571) 272-1702. The fax phone

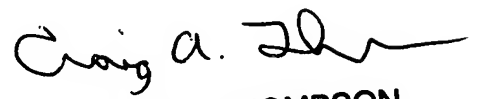
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number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Jennifer M. Dolan
Examiner
Art Unit 2813

jmd


CRAIG A. THOMPSON
PRIMARY EXAMINER